# Atlantic Mud Crab

*Panopeus herbstii* (H. Milne Edwards 1834)

Contributors: Amy E. Fowler and Peter Kingsley-Smith [SCDNR]

Photos courtesy of SERTC

DESCRIPTION

## Taxonomy and Basic Description

The Atlantic mud crab or black-fingered mud crab, *Panopeus herbstii* (H. Milne Edwards 1834), belongs to the super family Xanthidae (family Panopeidae) and is the largest of mud crab species, with the exception of the stone crab, *Menippe mercenaria* (Ruppert and Fox 1988). *Panopeus herbstii* is a true crab, growing to a maximum carapace width of 6.4 cm (Ruppert and Fox 1988) and is distinguished from other mud crab species by its robust black or dark brown fingers (top and bottom portion of the claw) that fade into a pale white along the interior portion of the base of the claw. The outsides of the claws are often mottled. The claws themselves are dissimilar in size, with the larger one having a curved upper finger and an enlarged white tooth at the base and the smaller one exhibiting a nearly straight lower finger (Williams 1984). The brownish green, slightly granular carapace of *P. herbstii* is approximately ⅔ as long as it is wide and has five teeth on the anterolateral margins of which the first two are mostly fused (Williams 1984). Ryan (1956) found a red spot to be present on the third maxilliped (feeding appendage) of males and some females (Williams 1984).

## Status

*Panopeus herbstii* is currently not included on any Federal lists of threatened or endangered species and there is no human exploitation of this species. As the dominant mud crab species in salt marshes along the Mid-Atlantic coast of the United States (Daiber 1982; Williams 1984), however, *P. herbstii* plays a key role in the food web structure of this ecosystem on a regional scale (Silliman et al. 2004) and may be a potential indicator of the heath of that particular ecosystem.

POPULATION SIZE AND DISTRIBUTION

*Panopeus herbstii* inhabits oyster reefs, mangrove swamps, and salt marshes along the Atlantic Coast of North America, from Massachusettes to Brazil and on Bermuda (Williams 1984). While the maximum age of *P. herbstii* is unknown, it is thought to vary between populations along the latitudinal gradient and to be driven by differences in temperature and food availability. The population density of *P. herbstii* can vary over small spatial scales; in a survey

of salt marshes from Delaware to North Carolina, densities ranged from 0 to 82 individuals per square meter, with individuals positively associated with the height of the associated cord grass, *Spartina alterniflora*, and the availability of bivalve prey (Silliman et al. 2004). Like other crustaceans, the timing of *P. herbstii* reproduction is seasonally dependent on water temperature and food availability and therefore can vary between populations along the coast (Williams 1984). After hatching, the planktonic larva stays within the estuary (Dittel and Epifanio 1982) and molts through four zoeal stages and a megalopa stage before metamorphosing into the juvenile stage (Williams 1984).

## HABITAT AND NATURAL COMMUNITY REQUIREMENTS

The type localities for *Panopeus herbstii* are oyster beds and mangrove swamps from the intertidal zone to 22 meters in depth (Williams 1984). Both adults and juveniles can be found on muddy bottoms or areas covered with shells and/or stones or in shallow burrows (4-10 cm) along the edges of the higher marsh (Williams 1984; Dittel et al. 1996). While little empirical work has been conducted on the temperature and salinity tolerances of this species, the broad latitudinal gradient that it encompasses suggests that it has the potential to withstand wide ranges. Individuals have been kept in the laboratory at temperatures between 5°C and 30°C (Dame and Vernberg 1978) and have been observed in brackish water estuaries above 10 ppt (Gosner 1978; Rodriguez and Epifanio 2000).

Primarily carnivorous, adult and juvenile *P. herbstii* have been documented to consume oysters, clams, crustaceans, annelid worms, fish, and snails (McDermott 196; Castagna and Kraeuter 1977; Whetstone and Eversole 1981; Silliman and Bertness 2002; Silliman et al. 2004; Tolley and Volety 2005) and play an important role as prey items for a variety of birds, fish, and larger crustaceans (Grabowski 2004). Silliman et al. (2004) showed that predation by *P. herbstii* on the marsh periwinkle (*Littorina irrorata*) population had a positive effect on salt marsh vegetation growth. The megalopae of *P. herbstii* prey upon other zooplankton (Harvey and Epifanio 1997) but are also prey for blue crabs, shrimp, and fish species (Dittel et al. 1996).

## CHALLENGES

As one of the most important habitats for *Panopeus herbstii* is oyster reef, the declining populations of oysters, especially the Eastern oyster, *Crassostrea virginica*, could be detrimental for *P. herbstii* populations. Populations of *C. virginica* have declined along much of the Mid-Atlantic Coast of the United States during the last century due to a combination of over-harvesting (Gross and Smyth 1946), habitat degradation (Rothschild et al. 1994), reduced water quality (Seliger et al. 1985), disease (Ford and Tripp 1996; Lenihan et al. 1999), the interactions among these factors (Lenihan and Peterson 1998), and ecosystem shifts (see Rothschild et al. 1994; Luckenbach et al. 1999; Dame et al. 2002). Wild populations of *C. virginica* are harvested both commercially and recreationally in South Carolina, and aquaculture on leased grounds (culture and mariculture permit areas) is increasing. Although *C. virginica* in South Carolina have not been as extensively exploited as the *C. virginica* populations in the mid-Atlantic states, the rapid pace of coastal development has created numerous threats to tidal creek habitats with inevitable undesirable impacts (e.g. Lerberg et al. 2000, Van Dolah et al. 2004, Holland et al. 2004). Threats involve increased runoff from upland clearing and associated non-pervious

surfaces; contaminants (particularly detrimental to larval stages) such as pesticides and heavy metals (see Capuzzo 1996 and Roesijadi 1996, respectively, for recent reviews); water quality closures resulting in concentrated harvest pressure on open, harvestable beds; impacts from dredging and other channel manipulations; and boat-related impacts.

## CONSERVATION ACCOMPLISHMENTS

Due to their importance as habitat for several species of conservation concern in South Carolina, including *Panopeus herbstii*, oyster reefs are also considered critical habitats of concern in both the State Conservation Plan and this State Wildlife Action Plan. As such, the South Carolina Department of Natural Resources (SCDNR) and others are actively involved in the restoration and enhancement of oyster reef habitat. Newly created oyster reefs provide the foundation for the settlement of oyster larvae that will eventually develop into natural oyster habitat. These new oyster reefs will benefit *Panopeus herbstii* and all of the associated marine species that utilize this habitat. To ensure that populations of *C. virginica* in South Carolina remain abundant, extensive efforts at the SCDNR Marine Resources Division, both by the Office of Fisheries Management and the Marine Resources Research Institute Shellfish Research Section, continue to be directed towards assessments of the distribution of *C. virginica* statewide to monitor changes in the acreage and condition of intertidal oyster reef habitat using ground-, boat-, and helicopter-based survey techniques.

## CONSERVATION RECOMMENDATIONS

- Assess the impacts of oyster reef restoration projects on *Panopeus herbstii* populations in South Carolina.
- Establish estimates of population size and determine population trends for *Panopeus herbstii* in South Carolina by widespread and long-term monitoring of their abundance, both in oyster reef habitats as well as alternative habitats.
- Understand the importance of *Panopeus herbstii* in the overall marine species community structure on oyster reef habitats in South Carolina.
- Develop a state or federal management plan for *Panopeus herbstii* based on population assessments.
- Continue SCDNR and others' oyster reef restoration and enhancement projects to ensure viable habitat exists for *Panopeus herbstii* and other marine species that rely on this important ecosystem engineer.

## MEASURES OF SUCCESS

If measures of abundance and population demographics of *Panopeus herbstii* are conducted as part of regular monitoring efforts that are currently established to monitor macroinvertebrates associated with oyster reefs, this could be a cost-effective way to collect data to provide baseline information. If continued over a longer period, these data would be able to follow population trends, which will allow managers to make decisions regarding possible conservation measures for this species. The overall measure of success for *Panopeus herbstii* will be stable population trends along the entire coast, as part of the increased conservation and restoration of oyster reef habitat in South Carolina.

LITERATURE CITED

Capuzzo, J.M. 1996. The bioaccumulation and biological effects of lipophilic organic contaminants (Chapter 15). *In*: Kennedy, V.S., Newell, R.I.E. & Eble, A.F. (eds), *The Eastern oyster*, Crassostrea virginica. Maryland Sea Grant College, University of Maryland System, College Park, Maryland, pp. 539-557.

Castagna, M and JN Kraeuter. 1977. *Mercenaria* culture using stone aggregate for predator protection. *Proc. Natl. Shellfish Assoc.* 67: 1-6.

Dame R.F., Bushek, D., Allen, D., Lewitus, A.J., Edwards, D., Koepfler, E. and Gregory, L. 2002. Ecosystem response to bivalve density reduction: management implications. *Aquat. Ecol.* 36:51–65.

Dittel, AR and CE Epifanio. 1982. Seasonal abundance and vertical distribution of crab larvae in Delaware Bay. *Estuaries.* 5: 197-202.

Dittel, AR, Epifanio, CE and C Natunewicz. 1996. Predation on mud crab megalopae, *Panopeus herbstii* H. Milne Edwards: effect of habitat complexity, predator species and postlarval densities. *J. Exp. Mar. Biol. Ecol.* 198: 191-202.

Ford, S.E. and Tripp, M.R. 1996. Diseases and defense mechanisms. *In*: Kennedy, V.S., Newell, R.I.E., Eble, A.F. (eds), *The Eastern oyster*, Crassostrea virginica. Maryland Sea Grant, College Park, MD, pp. 581-660.

Gosner, KL. 1978. *A field guide to the Atlantic seashore: Invertebrates and seaweeds of the Atlantic coast from the Bay of Fundy to Cape Hatteras.* Houghton Mifflin Co. Boston, MA. USA. 329 pp.

Grabowski, JH. 2004. Habitat complexity disrupts predator-prey interactions but not the trophic cascade on oyster reefs. *Ecology.* 85: 995-1004.

Gross, F. and Smyth, J.C. 1946. The decline of oyster populations. *Nature* 157:540-542.

Harvey, EA and CE Epifanio. 1997. Prey selection by larvae of the common mud crab *Panopeus herbstii* Milne-Edwards. *J. Exp. Mar. Biol. Ecol.* 217: 79-91.

Holland, F., Sanger, D., Gawle, C.P., Lerberg, S.B., Santiago, M.S., Riekerk, G.H.M. and Zimmerman, L.E. 2004. Linkages between tidal creek ecosystems and the landscape and demographic attributes of their watersheds. *J. Exp. Mar. Biol. Ecol.* 298:151-178.

Lenihan, H.S., Micheli, F., Shelton, S.W. and Peterson, C.H. 1999. The influence of multiple environmental stressors on susceptibility to parasites: an experimental determination with oysters. *Limnol. Oceanogr.* 44:910-924.

Lenihan, H.S. and Peterson, C.H. 1998. How habitat degradation through fishery disturbance enhances impacts of hypoxia on oyster reefs. *Ecol. Appl*. 8:128-140.

Lerberg, S.B., Holland, A.F. and Sanger, D.M. 2000. Responses of tidal creek macrobenthic communities to the effects of watershed development. *Estuaries* 23:838-853.

Luckenbach, M.W., Mann, R. and Wesson, J.A. (eds.) 1999. *Oyster reef habitat restoration: a synopsis and synthesis of approaches.* Virginia Institute of Marine Science Press, Gloucester Point, VA, 358 pp.

McDermott, JJ. 1960. The predation of oysters and barnacles by crabs of the family Xanthidae. *Proc. Pennsylvania Acad. Sci.* 34: 199-211.

Roesijadi, G. 1996. Environmental factors: responses to metals (Chapter 14). *In*: Kennedy, V.S., Newell, R.I.E. & Eble, A.F. (eds), *The Eastern oyster*, Crassostrea virginica. Maryland Sea Grant College, University of Maryland System, College Park, Maryland, pp. 515-537.

Rodriguez, RA and CE Epifanio. 2000. Multiple cues for induction of metamorphosis in larvae of the common mud crab *Panopeus herbstii*. *Mar. Ecol. Prog. Ser.* 195: 221-229.

Rothschild, B.J., Ault, J.S., Goulletquer, P. and Héral, M. 1994. Decline of the Chesapeake Bay oyster population: a century of habitat destruction and overfishing. *Mar. Ecol. Prog. Ser.* 111:29-39.

Ruppert, EE. and RS Fox. 1988. *Seashore animals of the Southeast: A guide to common shallow-water invertebrates of the southeastern Atlantic coast.* University of SC Press. Columbia, SC. USA. 429 pp.

Ryan, E.P. 1956. Observations on the life histories and the distribution of the Xanthidae (mud crabs) of Chesapeake Bay. American Midland Naturalist 56: 138-162, 2 plates.

Seliger, H.H., Boggs, J.A. and Biggeley, W.H. 1985. Catastrophic anoxia in the Chesapeake Bay in 1984. *Science* 228:70-73.

Silliman, BR and MD Bertness. 2002. A trophic cascade regulates salt marsh primary production. *Proc. Nat. Acad. Sci.* 99: 10500-10505.

Silliman, BR, Layman, CA, Geyer, K and JC Zieman. 2004. Predation by the black-clawed mud crab, *Panopeus herbstii*, in Mid-Atlantic salt marshes: further evidence for top-down control of marsh grass production. *Estuaries.* 27: 188-196.

Tolley, S.G. and Volety, A.K. 2005. The role of oysters in habitat use of oyster reefs by resident fishes and decapod crustaceans. *J. Shellfish Res.* 24:1007-1012.

Van Dolah, R.F., Jutte, P.C., Riekerk, G.H.M., Levisen, M.V., Crowe, S.E., Lewitus, A.J., Chestnut, D.E., McDermott, W., Bearden, D. and Fulton, M.H. 2004. The condition of South Carolina's estuarine and coastal habitats during 2001-2002: Technical Report. SCDNR – Marine Resources Research Institute. 70 pp.

Whetstone, JM and AG Eversole. 1981. Effects of size and temperature on mud crabs, *Panopeus herbstii*, predation on hard clams, *Mercenaria mercenaria*. *Estuaries.* 4: 153-156.

Williams, AB 1984. Shrimps, lobsters, and crabs of the Atlantic coast of the Eastern United States, Maine to Florida. Smithsonian Institution Press. pp. 412–413. ISBN 0-87474-960-3.